1994. The Journal of Arachnology 22:114–130

SPIDERS OF AN OLD FIELD HABITAT IN THE DELTA OF MISSISSIPPI

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ABSTRACT. Over a 14-month period, 2785 spiders of 70 species were collected by 114 pitfall trap samples and 68 sweepnet samples in a 2.5 ha abandoned horse pasture adjacent to a cotton field in Washington County, Mississippi. Mean numbers of spiders per sample were approximately equal by pitfall ($\bar{x}$ = 15) and sweepnet ($\bar{x}$ = 16) methods. Individuals of the Lycosidae (42.6%), Thomisidae (16.2%), and Salticidae (14.4%) comprised almost three-fourths of all spiders collected. Individuals of 13 other families were also collected. Web-spinners comprised 21.4% of the species (n = 15) and 13.9% of the individuals (n = 386), whereas wanderers comprised 78.6% of the species (n = 55) and 86.1% of the individuals (n = 2399). Eighteen species occurred only in the sweepnet (foliage) samples, 31 species only in the pitfall (ground) samples, and 21 species occurred in both sampled strata. Foliage spiders (mostly immatures) reached peak population levels in June and July and again in October and November. Very low densities occurred in August and September, with intermediate levels throughout the winter and spring leading to peak adult densities in April. Ground spiders reached peak population levels in March (mostly adults) and July (mostly immatures). A comparison of the composition and structure of this spider community with other old field sites and other potentially adjacent crop and non-crop habitats suggests considerable similarity. A possible role for spiders in cotton pest management is considered.

Several reviews in the last 15 years have suggested that spiders are potential control agents of some pests in certain crops (Young & Edwards 1990; Nyffeler & Benz 1987; Reichert & Lockley 1984; Luczak 1979). In cotton, surveys have indicated a large and diverse community of spiders (Mysore & Pritchett 1986; Dean et al. 1982; Whitcomb et al. 1963a). In Washington County, Mississippi, over 60% of the land area is under cultivation, with cotton the principal crop (Gunn et al. 1980). Because cotton is an annual crop that is planted in fields usually left barren during the fall, winter, and spring, spiders must recolonize cotton fields each year by dispersing from adjacent habitats. These habitats can be nurseries for general predators such as spiders (Altieri & Whitcomb 1979), though in these habitats little is known about spider species composition, guild structure, population density, and temporal patterns of occurrence (Lockley & Young 1986a). Numerous studies, however, have demonstrated that spiders are the most abundant group of predators in many of these habitats (e. g., Smith et al. 1985; Fuchs & Harding 1976; Moulder & Reichle 1972). Field observations and laboratory experiments also have shown that many of the spider species occurring in these habitats can prey on cotton pests (e. g., Young 1989a, b; Lockley & Young 1986b). In this report we document the spatial and temporal occurrence and species composition of the spider community in an old field habitat, consider the potential impact of an adjacent cotton field on this community, and compare our results with other studies of old field and similar habitats.

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METHODS

Site description.—The study site was a 2.5 ha old field habitat 3 km SSE of Leland, Washington County, Mississippi (Site 1 of Young & Welbourn 1987, 1988). This fenced area had been a pasture for horses and was routinely mowed once a year in the autumn. It was last mowed in 1983 and horses were removed in late 1984. The site was bordered on the east by a narrow paved road and adjacent 32 ha cotton field, on the north by a residence in a woodlot, on the west by a deciduous tree-lined creek, and on the south by old field habitat. There were three distinct zones of vegetation and soil in this field. Nearest the road (east) was a north-south strip 20 m wide, sparsely covered with clovers and grasses. The soil was a heavy clay/loam mixture, and when very dry in mid- and late-summer the surface contained many wide and deep cracks. Scattered clumps of *Erigeron strigosus* Willd. and *Anthemis cotula* L. were the principal flowering forbs in early and mid summer, with *Erigeron canadensis* L., *Aster pilosus* Willd., and *Helenium amarum* (Rafin.) dominant in late summer and autumn. Nearest the creek (west) and its associated trees was a north-south strip 10 m wide and shaded daily beginning in mid-afternoon. Horses had extensively trampled and fed in this area and the vegetation was mostly *Cynodon dactylon* (L.) and *Sorghum halepense* (L.). Scattered clumps of *E. canadensis* and *Carduus* L. spp. bloomed in late summer, with senescence of all plants by late October. The soil was sandy loam, but was well-packed and drained somewhat better than the clay/loam section. The center section of the field was porous sandy loam with a dense cover of forbs, which included *Amaranthus* L. sp., *Oenothera* L. spp., and *Solidago altissima* L. Senescence occurred in late November, and in the spring of 1986 *Vicia sativa* L. over-grew much (50%) of the vegetation in this and the eastern sections.

Trap description.—Six pitfall traps were placed in the field, two in each of the sections (east, center, west). Metal oil cans (946 ml, 10 cm diameter, 14 cm high) with the tops removed were placed in the ground with the top rim protruding *ca.* 6 mm above the soil surface. Soil was packed around the can to form a low cone up to the rim. Inserted in each can was a removable plastic cup (473 ml, 10 cm diameter, 13 cm high) containing *ca.* 100 ml of a 50% solution (in water) of commercial auto antifreeze (ethylene glycol). Traps were placed in pairs one meter apart and connected by a sheet metal barrier 10 cm high, embedded 2.5 cm into the soil, and oriented north-south. Supported 5 cm over each trap by three wood dowels was an aluminum pie plate (20 cm diameter) spray-painted dark green.

Sampling procedures.—Pitfall traps were emptied and refilled with preservative at weekly or biweekly intervals (depending on temperature and associated arthropod activity levels) from March 1985 to May 1986. Contents of each pair of traps were pooled as one sample. Sampling of the above-ground foliage with a sweepnet (39 cm diameter, 10 sweeps per sample) was conducted mid-morning during the same intervals, one sample in each of the three sections. Material from pitfall traps and sweepnet samples was brought into the lab and refrigerated (pitfall) or frozen (sweepnet) for an indefinite period. Samples were subsequently sorted, identified, and tabulated. Unidentified material and voucher specimens were stored in alcohol for further processing.

RESULTS

Total spider fauna.—During the period March 1985 to May 1986, 114 pitfall trap samples of the ground stratum community and 68 sweepnet samples of the foliage stratum community obtained 2785 spiders of 70 species. Pitfall traps captured 1689 individuals of 53 species, for a mean of 15 spiders per sample and a mean of 32 individuals per species. Sweepnet sampling captured 1096 individuals of 37 species, for a mean of 16 spiders per sample and a mean of 30 individuals per species (Appendix A).

Sixteen families of spiders were represented at the study site (Table 1). Members of the Lycosidae (42.6%), Thomisidae (16.2%), and Salticidae (14.4%) comprised almost three-fourths of all spiders collected. In the ground stratum, members of the Lycosidae were most abundant (68%). In the foliage stratum, members of the Salticidae (32.7%), Thomisidae (25.0%), and Oxyopidae (23.5%) were most abundant.

A variety of analytical methods was employed in comparisons of the spider assemblage in each of the three sampling areas within the study site. Though some minor differences were detected, particularly in seasonal distribution of immatures, we concluded that the apparent (to us) differences in vegetation and soil of the three sites were not reflected in significant differences in spider distribution, density, or composition. Thus for the purposes of subsequent analyses the data from the three sites were combined.

Comparison of strata.—Species composition of the two strata exhibited a 30% overlap, with 21 species occurring in both strata, 31 species present only in the ground stratum, and 18 species found only in the foliage (Appendix A). Peak seasonal population densities on the ground occurred in March and July, whereas peak population densities on foliage occurred in June, July, October, and November (Fig. 1).

The age distribution of the foliage assemblage was skewed toward the younger stages, with 86.1% immature and 13.9% adult. The seasonal distribution of these age classes on foliage demonstrated early summer and late autumn popula-

Table 1.—Summary by family and guild of spiders captured in an old field habitat, Washington County, Mississippi, March 1985–May 1986. Numbers in columns represent species, with the number of individuals in parentheses.

	Web-spinning			Wandering		No. of species (individuals) as % of total
	Orb	Sheet	Matrix	Active	Ambush	
Agelenidae		1 (27)				1.4 (1.0)
Anyphaenidae				1 (1)		1.4 (<1)
Araneidae	6 (56)					8.6 (2.0)
Clubionidae				3 (11)		4.3 (<1)
Dictynidae			1 (4)			1.4 (<1)
Gnaphosidae				7 (65)		10.0 (2.3)
Hahniidae		1 (47)				1.4 (1.7)
Linyphiidae		3 (245)				4.3 (8.8)
Lycosidae				18 (1187)		25.7 (42.6)
Oxyopidae				1 (264)		1.4 (9.5)
Pisauridae				1 (18)		1.4 (<1)
Salticidae				16 (402)		22.9 (14.4)
Theridiosomatidae	1 (1)					1.4 (<1)
Theridiidae			1 (3)			1.4 (<1)
Thomisidae					8 (451)	11.4 (16.2)
Uloboridae	1 (4)					1.4 (<1)
Totals	8 (61)	5 (315) = 15 (387)	2 (7)	47 (1948) = 55	8 (451) (2399)	100 (100)
Percentages	11.4 (2.2)	7.2 (11.5) = 21.4 (13.9)	2.8 (0.2)	67.2 (69.9) = 78.6	11.4 (16.2) (86.1)	

tion peaks for immatures and a considerably lower spring population peak for adults (Fig. 2). Within the foliage assemblage, three families (Salticidae, Thomisidae, Oxyopidae) represented 81.2% of all individuals collected. The seasonal distribution of these families demonstrated peak densities of Salticidae in June and July, Thomisidae in October, and Oxyopidae in November and January. The most abundant species in the foliage stratum was *Oxyopes salticus* Hentz (Oxyopidae), representing 23.5% of all foliage spiders (Appendix A).

The ground population was more evenly distributed between adult and immature stages than the foliage assemblage, with 47.1% immature and 52.9% adult. Peak adult population density occurred between March and May, followed by peak immature density between July and September (Fig. 3). Sixty-eight percent of the ground spider community was composed of lycosid individuals. Within the adult portion of this family, *Pardosa milvina* (Hentz) was captured most frequently in April and May of the first year, as were *Lycosa* spp. in April and May of the second year. *Allocosa absoluta* (Gertsch) was the most frequently captured species in July and August, and *Schizocosa ocreata* (Hentz) occurred at low levels intermittently throughout the year. For immature Lycosidae, *Lycosa* spp. were captured most frequently, particularly in July, September, and May. *Schizocosa* spp. occurred most frequently in August and October, and members of the *Allocosa* and *Pardosa* occurred at low levels throughout most of the year (Appendix A).

Comparison of guilds.—Spiders can be classified as obtaining their food either by spinning webs or by wandering (Comstock 1940). Considering the spider assemblage captured at the study site, 78.6% of the species (n = 55) were wanderers, as were 86.1% of the individuals (n = 2399). Only 21.4% of the species (n = 15) were web-spinners, as were 13.9% of the individuals (n = 386) (Table 1). Web-spinners were most frequently captured in early spring (March) of both years, with captures declining to almost zero in autumn (October) (Fig. 4). The wanderer population was captured most frequently in the spring, summer, and autumn, with peak captures in July exceeding 50 per sample, compared to only 5 per sample for web-spinners (Fig. 4).

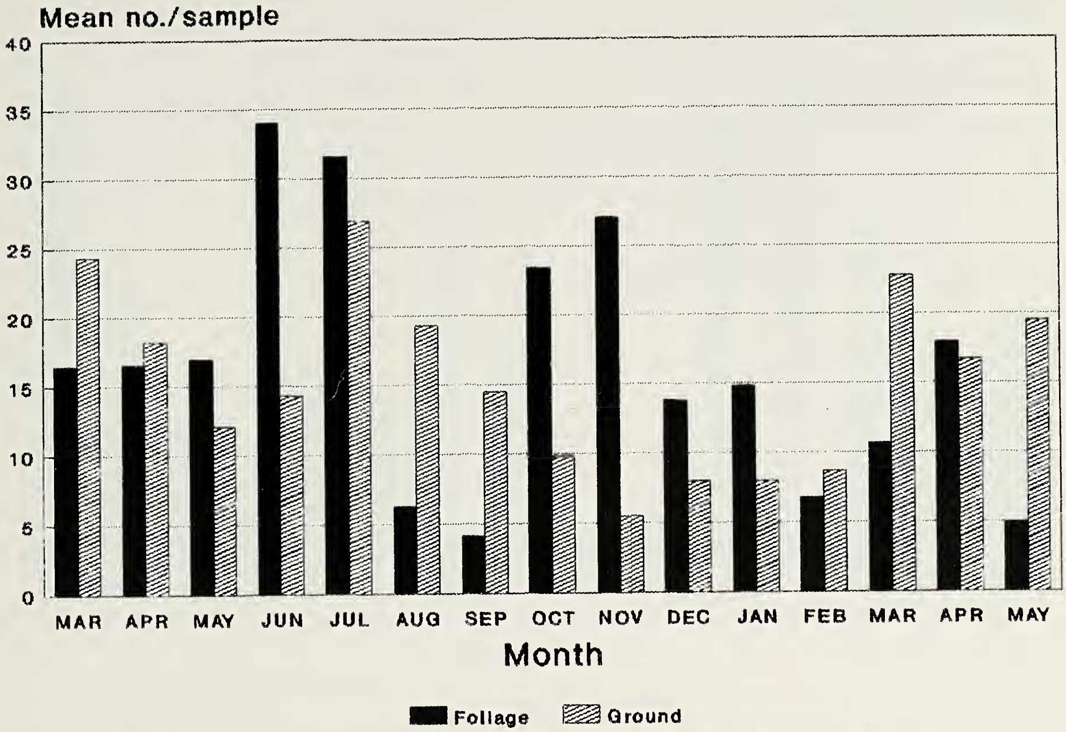

Figure 1.—Seasonal distribution of foliage and ground spiders in an old field habitat.

The spider assemblage at the family level can also be divided into five, rather than two, food-gathering guilds (e. g., Young & Edwards 1990). Subdividing the web-spinning guild into orb, sheet, and matrix guilds indicates that individuals of the sheet-web guild were the most numerous, but more species occurred from the orb-web families (Table 1). Subdividing the wandering guild into active and ambush guilds indicates that individuals and species of the active guild were the most numerous.

DISCUSSION

General considerations.—An old field can be characterized as a habitat in the early stages of succession from an abandoned pasture, previously plowed crop field, or other disturbed habitat. In the Delta area of Mississippi, old field sites are usually former fields of cotton or soybean that have been left fallow for 2–5 years. Tall perennial herbs such as *Solidago* spp. and *Erigeron* spp. are abundant at these sites, with scattered tree saplings and climbing vines such as *Lonicera* spp. usually present. Patches of low-growing grasses and herbs such as *Trifolium* spp. and *Ranunculus* spp. also are scattered throughout, along with various creeping plants. This diversity of plant size and structure is in marked contrast to that found in adjacent cotton fields. After cotton harvest in September or October, stalks are plowed under and the field remains barren until planting the following April or May. Subsequent cultivations and herbicide applications eliminate most other plants from the field and ensures a cotton monoculture. Intensive application of insecticides during the growing season also eliminates most arthropods, including spiders.

The frequent aerial application of insecticides to cotton typically results in drift of this material onto adjacent habitats. Mortality of arthropods may occur in adjacent habitats as a result of insecticidal drift. Thus the spider community as documented in the present study may be typical of old field habitats adjacent to intensively sprayed agricultural sites, but not of old field habitats situated elsewhere.

The sampling procedures used in this study may also be a source of bias. Pitfall trapping frequently has been criticized as a population sampling method for spiders and other arthropods, primarily because the traps do not distin-

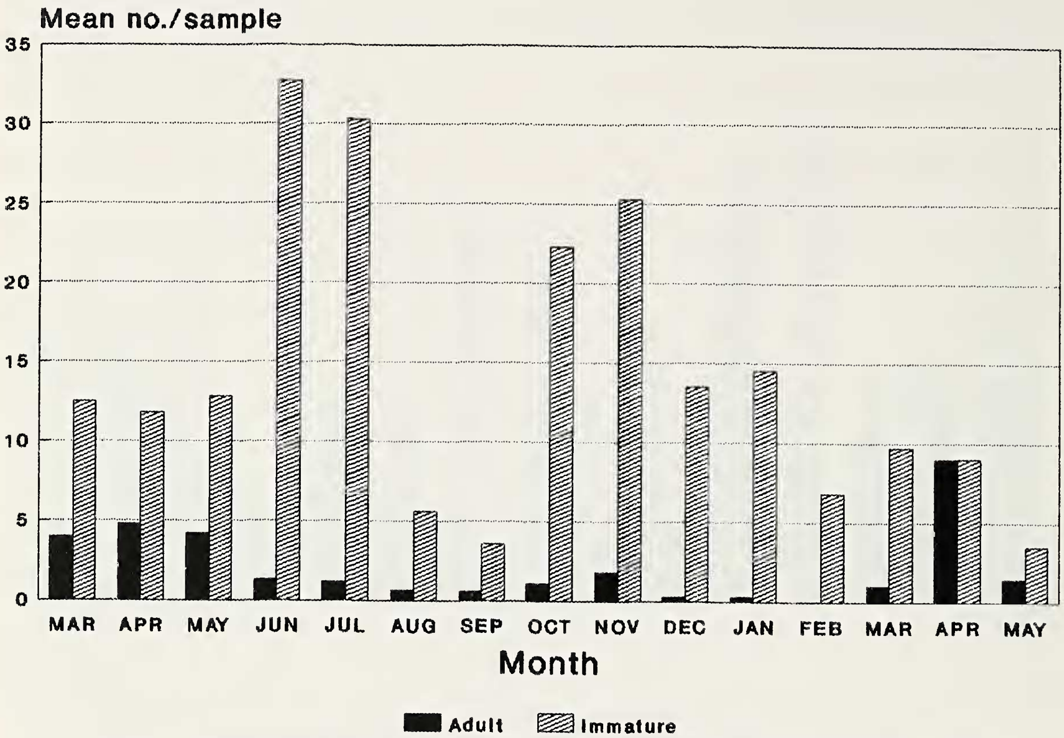

Figure 2.—Seasonal distribution of adult and immature foliage spiders in an old field habitat.

guish between population density and activity levels (e. g., Uetz & Unzicker 1976). Procedures that are more precise and discriminating, such as whole-plant fumigation, are often prohibitive in time and manpower and regrettably were not used in the present study. An analysis of the efficiency of various types of pitfall traps (Curtis 1980) also suggests that the traps used in the present study may have undersampled some spider populations due to a trap cover, and oversampled some spider populations by the use of a potentially attractive liquid preservative. Barriers connected to pitfall traps, as used in the present study, may have oversampled active spiders, but there is no data in the spider literature to support or refute this possibility. The "sweeping" technique for sampling spider populations on vegetation also has been criticized (Duffey 1974). As a simple and inexpensive method it is often preferred to foliage-sampling techniques such as vacuum, visual, and whole-plant examination, though it may be the most biased.

A comparison of the relative proportions of the spider community comprising wanderers and web-spinners in this old field site with other sites also suggests a rather atypical situation. In this Washington County old field habitat, 21% of the species were web-spinners and 79% were wanderers. A seven year survey of all habitats in Washington County, including old field habitats and agricultural fields, demonstrated a considerably larger percentage (33%) of web-spinners (Young et al. 1989). A literature survey of spider research in field crop habitats of the United States indicated that 44% of the species were web-spinners, whereas an analysis of the entire North American spider fauna, in all habitats, demonstrated that 59% of the species were web-spinners (Young & Edwards 1990). This trend suggests that the web-spinning spider community in the Delta area of Mississippi is depauperate, perhaps due to the high percentage of the land devoted to annual crops, the associated disturbance of adjacent habitats, and the extensive use of pesticides affecting both areas. Web-spinners seem to be more affected by these factors and thus represent a smaller proportion of the community, even in an old field habitat island that is relatively undisturbed.

Comparison with other old field habitats.—In North America, there is no published study of the spider community in old field habitats ad-

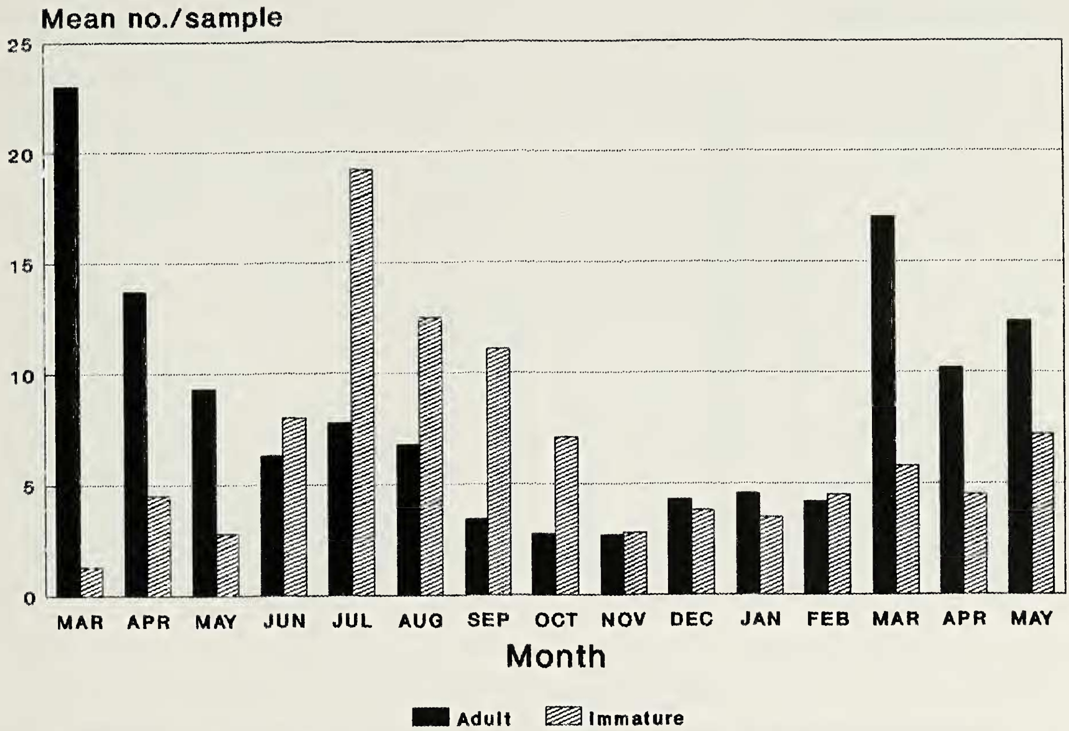

Figure 3.—Seasonal distribution of adult and immature ground spiders in an old field habitat.

jacent to cotton or to any other field crop. In fact, there are very few surveys of any old field sites for spiders. Several reports document the spider community on foliage in a old field habitat, but do not include sampling of the ground surface (MacMahon & Trigg 1972, Cannon 1965). In Ohio, MacMahan & Trigg (1972) sampled by sweepnet a seven year old field for four months and obtained 63 species of spiders. Four species constituted 77% of all captures (n = 2079), and species composition was constant throughout the sampling period. Analyses of guild or age structure of the community were not performed. Another Ohio old field site was sampled by Cannon (1965). Twenty-five species and 125 individuals were captured by sweepnet during a three-month period, with web-spinners representing a third of the individuals. Other community information and analyses were not presented.

Several reports document the spider community on the ground surface in an old field habitat, but do not include sampling of the herbaceous stratum (Haskins & Shaddy 1986, Bultman et al. 1982). In Missouri, several four year old fields were sampled by pitfall traps for eight months (Haskins & Shaddy 1986). Sixty species and 868 adult individuals were obtained, with lycosids the most abundant family and web-spinners usually representing less than 20% of the individuals. Other guild and age structure analyses were not presented. In another study, a seven year old field in Michigan was sampled by pitfall traps for three months with 21 species of spiders and 243 individuals captured (Bultman et al. 1982). Members of the Lycosidae constituted over 70% of the ground surface community and web-spinners accounted for only 20% of the individuals.

One unpublished study examined both the herbaceous and the ground strata in three old fields in Indiana over a 13-month period (Snyder 1970). Unfortunately, the sample size was quite small (85 individuals captured by sweepnet, 26 by pitfall), and one species, *Neon nellii* Peckhams (Salticidae) represented 35% of the ground-active population. Other analyses of community characteristics were not performed.

The spider communities in the old field sites cited above may be similar to the Mississippi old field described herein, though it is difficult to determine from the published information. The number of foliage species at all sites ranged from

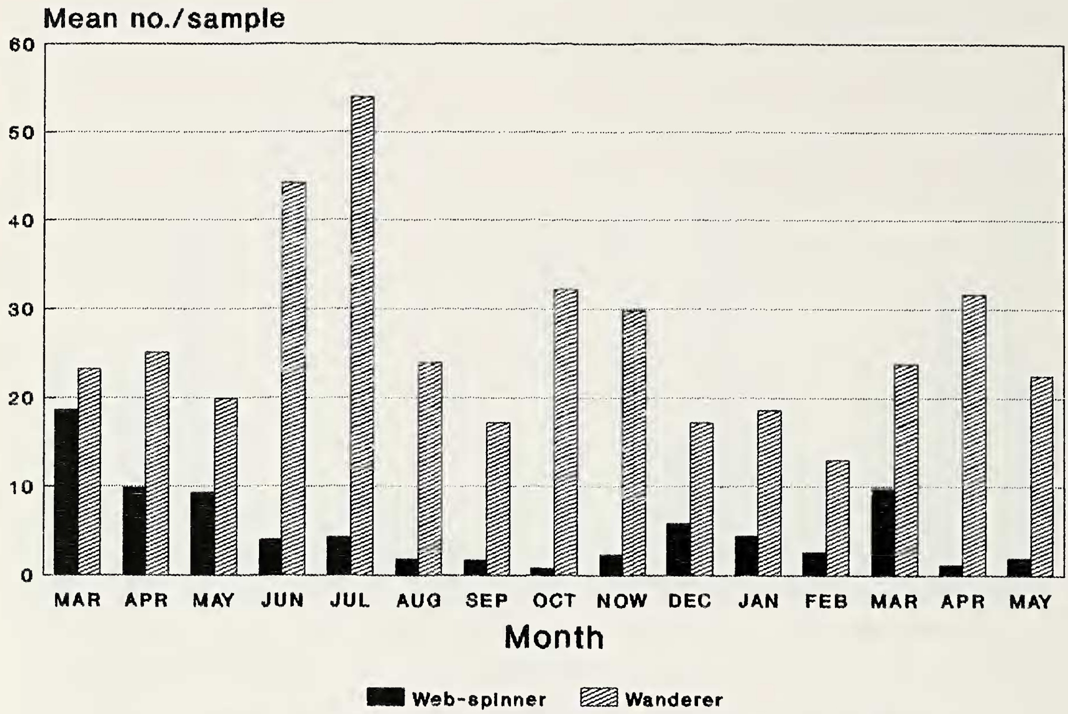

Figure 4.—Seasonal distribution of web-spinner and wanderer spiders in an old field habitat.

25–63 and the number of ground species ranged from 21–60. Members of the wandering guild were the most abundant group in both the foliage and the ground strata, with web-spinners representing 20–40% of the assemblage. These values, and all other potential comparisons, however, may be strongly influenced by differences between studies in the length and intensity of the sampling effort.

Relation of old field spider community to adjacent cotton habitat.—Crop fields that are harvested in the fall, plowed, and left barren until the spring growing season support few if any spider species during the barren period (Duffey 1978). Consequently, annual crops such as cotton must be colonized by spiders from adjacent or other habitats. The ultimate density of spiders in cotton fields each season therefore may be a function of the species assemblage in adjacent habitats and their proximity (Plagens 1983). For example, the spider community is usually larger in cotton fields adjacent to alfalfa, peanuts, and corn than in cotton fields adjacent to soybean (Robinson et al. 1972). Foliage spiders usually are more numerous in cotton fields adjacent to pasture or brushy habitats than to grassy or woodland habitats (Skinner 1974). Ground spiders can be more numerous in cotton fields adjacent to pasture than to woody areas (Whitcomb et al. 1963b). The proportion of the spider community at the species level that moves into cotton fields from all types of adjacent habitats, however, may be rather small, for example only 19% in Mississippi Delta cotton (Young et al. 1989).

The spider community of cotton in the U. S. A. has been examined in at least six states, and along with the spiders of soybean and alfalfa are among the best known of crop spider communities (Young & Edwards 1990). More species of spiders (308) have been reported from cotton than from any other field crop, and spiders in cotton are often the numerically dominant predator (e. g., Smith & Stadelbacher 1978). The ecological and behavioral characteristics of the cotton spider community, however, are not well known.

Concurrent with the present old field study, regular collections of spiders were initiated in the adjacent cotton field. This field was supposed to have been maintained without pesticides for the entire growing season. When the first cotton pests appeared in late May, however, the grower changed his mind and began a weekly program of aerial spraying. Not surprisingly, spider populations were essentially non-existent after several applications of pesticides. Between the planting of the crop in late April and the start of spraying, very little spider colonization of the field occurred.

In previous years, spiders had been collected intermittently from other cotton fields in Washington County (Young et al. 1989). Of the 37 spider species captured on foliage in the present old field habitat, 16 were also collected previously in cotton (43%). Of the 53 spider species captured on the ground in this old field habitat, only 12 were captured previously in cotton (23%). These values suggest a low colonization rate for spiders from an old field habitat into cotton. A survey of the literature associated with cotton spiders in Mississippi and adjacent states, however, reveals a different pattern (Young & Edwards 1990). Thirty-three of the 37 species of spiders on foliage (89%) and 39 of the 53 species captured on the ground (74%) in the Delta old field habitat also have been recorded from cotton at other locations. Based on this analysis, it appears that most species of spiders found in old field habitats can at least temporarily colonize adjacent cotton fields, but not necessarily in Washington County.

As previously indicated, not all species of spiders in old field habitats are found in cotton. This suggests that certain species or groups of species may be more likely to occur in both habitats and may have certain characteristics in common. Comparison of the two sampled strata indicates that foliage-inhabiting species are more likely than ground-inhabiting species to occur in both old field and cotton habitats. This phenomenon may be related to the modes of dispersal of the two groups. Foliage spiders are more likely to disperse by aerial ballooning than by walking, whereas the opposite is true for ground spiders (Duffey 1956). Aerial dispersal may be the more effective technique for moving large numbers of spiders the relatively long distances between habitats, though probably most dispersal occurs by walking (Meijer 1977). Comparison of the two foraging guilds indicates that species of web-spinning spiders, though comprising only 21% of the community in the old field habitat, are as equally likely as wanderers to occur in both habitats. Sixty-seven percent of the wandering species in the old field occur in cotton, as do 73% of the web-spinners.

The comparative age structures of the spider community in both habitats may indicate attributes important in colonization of cotton. During the period that cotton was present in the adjacent field (April-October), 68% of the population in the old field was immature. Surveys in cotton typically do not indicate the age structure of the entire spider community (e. g., Dean et al. 1982; Whitcomb et al. 1963a). There are, however, two published reports in the U. S. A. of the age structure of dispersing spider populations adjacent to field crops. Dean & Sterling (1985) documented in Texas during the period of April to August a dispersing population that was 83% immature. In Missouri, Greenstone et al. (1987) reported during the period of June to October a dispersing population that was 86% immature. An extrapolation from these surveys suggests that the spider population in the cotton field adjacent to the old field reported herein probably would contain on a seasonal basis approximately 85% immature spiders. The estimated higher density of immatures in cotton (85%) relative to the adjacent old field (68%) may indicate that immatures are the principal dispersing stage into cotton. Reproductive activity and generation of immatures (and adults) does occur in cotton (Whitcomb et al. 1963a), though late-season dispersal out of cotton before harvest and plant destruction is possible but undocumented.

Comparison with other field crops.—A body of literature does exist that compares in a habitat the ecological characteristics of foliage and ground spiders, and of different feeding guilds, but these data come not from old fields but from field crops. In Virginia soybean fields, Ferguson et al. (1984) demonstrated by pitfall trapping and sweepnetting that lycosids were the most abundant group of ground spiders and that oxyopids were the most abundant group on foliage. Peak population levels occurred on foliage in August and September, while ground populations peaked in June. These patterns were similar to those at the Washington County old field site. Culin & Rust (1980) used pitfall traps and the drop-cloth method in Delaware soybeans and reported that over twice as many species occurred in the foliage (105) as on the ground (48), with only two species found in both strata. Almost all of the species of foliage spiders were captured exclusively as adults, or as immatures, suggesting that those were the stages that had migrated into the crop and that no *in-situ* reproduction occurred. Such was not the case for ground spiders, indicating a more established and stable ground community. As in the Mississippi study site, *Oxyopus salticus*, *Misumenops* sp., and *Phidippus* spp. were dominant foliage spiders; and members of the Linyphiidae and the Lycosidae were dominant ground spiders.

In alfalfa, which is perennial and usually replanted in the south after three years, spider populations are stablized by the second year as compared with an annual crop such as soybeans (Culin & Yeargan 1983a, b). These studies in Kentucky demonstrated that spider populations in alfalfa foliage (suction sampled) peaked in late fall or winter, with a considerable overwintering population in the ground litter. The number of species on foliage (92) peaked in the second year and declined by 25% in the third year. By the third year, the number of species remained constant throughout the year. Ground-surface populations (pitfall sampled) peaked in June to August, with the most number of species also occurring at this time. The number of ground spider species, however, declined each year (78–64–57). The wandering guild on both foliage and the ground usually represented less than half of the total community on a seasonal basis and was never more abundant than web-spinners during any sampling period. Patterns of population abundance in the two strata were similar to those in the Washington County old field site; but patterns of relative guild abundance were markedly different, i. e., web-spinners were never more abundant than wanderers during any sampling period. These ecological patterns in alfalfa suggest an increasing stability of the spider community through time and may be typical of more advanced successional habitats such as old fields.

A very intensive examination by visual, nontrapping techniques was conducted on the spider community of corn in Florida (Plagens 1985). From all strata 140 species were identified, with the most abundant spiders including species of *Metaphidippus*, *Misumenops*, *Pardosa*, and *Peucetia*. Juvenile spiders usually outnumbered adults by 2:1, with similar seasonal trends for each age class. Foliage web-spinners usually were more abundant than foliage wanderers, and ground surface wanderers usually were more abundant than ground web-spinners. Of particular interest in this study is the demonstration of aerial movement between the corn fields and adjacent habitats. The intensity of movement as indicated by captures at sticky wire traps was relatively constant on a seasonal basis, though considerably less constant on a daily basis. Over an 18-month period approximately half of the migrants captured were web-spinners and half wanderers. Most of the aerial migrants were small and immature, with the 1.0–1.5 mm size class representing 45% of all captures. Considerable movement apparently occurred between the edge of the corn fields and adjacent wooded areas, as the distribution of many species was not random or evenly distributed throughout a corn field but clumped along the field margins.

Potential role of old field habitats in cotton pest control.—Habitats adjacent to cotton can serve as reservoirs for both cotton pests and their predators (Reynolds et al. 1982). The principal cotton pests in Mississippi are the tarnished plant bug, *Lygus lineolaris* (Palisot), the boll weevil, *Anthonomus grandis* Boh., the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter), the cotton aphid, *Aphis gossypii* Glover, and the bollworm and budworm, *Heliothis* spp. These pests can develop high population densities on host plants in adjacent habitats before migrating into cotton and causing damage. They subsequently can move out of cotton and overwinter in these same adjacent habitats (Young 1986).

Spiders can be important predators on cotton pests both in cotton and in adjacent habitats. In cotton, members of the genera *Argiope* (Nyffeler et al. 1987), *Lycosa* and *Metaphidippus* (Whitcomb et al. 1963a), and *Misumenops* (Plagens 1983), as well as *Lactrodectes mactans* (Fabr.) (Whitcomb et al. 1963a), *Oxyopes salticus* (Lockley & Young 1986b), and *Phidippus audax* (Young 1989d), are all documented predators on cotton pests. In adjacent habitats, species such as *Misumena vatia* (Clerck) (Lockley et al. 1989), *Pisaurina mira* (Walck.) (Young 1989b), and members of the genera *Lycosa* (Nyffeler et al. 1986) and *Misumenops* (Young 1989c) are also documented predators on cotton pests. Perhaps the most important spider species in crop pest control, however, are those that are active predators both in stable habitats and in adjacent crop areas.

There are several species groups of spiders that occur in high densities in both old field habitats and in cotton that would be prime candidates for a conservation/augmentation program directed toward increasing predation on cotton pests. In the ground strata, members of the lycosid genera *Schizocosa*, *Pardosa*, and *Lycosa*, and members of the thomisid genus *Xysticus* are abundant in both habitats. In the foliage strata, *Oxyopes salticus* Hentz (Oxyopidae), *Misumenoides formosipes* (Walck.) (Thomisidae), and members of the salticid genus *Phidippus* and the thomisid genus *Misumenops* are abundant in both habitats. These species are well documented as important predators on cotton pests and have the potential to be manipulated in various ways as part of a strategy of enhancing predation on cotton pests (Young & Edwards 1990).

CONCLUSION

Perhaps the most important conclusion that can be drawn from the preceding presentation of data and review of the literature is that very little is known about the ecology and behavior of spiders in cotton fields and adjacent habitats. The knowledge base may be only slightly improved in other crops and other adjacent habitats. Most of the available data have been collected in a descriptive manner and is certainly not standardized in such a fashion that suitable comparisons can be made between data sets. In truth, a definitive ecological study in the United States of the spiders of a field crop site and an adjacent habitat has yet to be published. Much more is known about pest species in these various habitats than any of their potential control agents, as for example the boll weevil and the bollworm (Metcalf & Luckmann 1982). There should be little doubt that considerable research involving spiders needs to be performed before they can be realistically considered as a manageable unit in an integrated pest control program, though recent progress in that direction is in evidence (e. g., Nentwig 1988; Riechert & Bishop 1990).

ACKNOWLEDGMENTS

We appreciate the identification of spiders and acceptance of voucher materials provided by G. B. Edwards, Florida State Collection of Arthropods, Gainesville, Florida. Other voucher material is deposited in the Mississippi Entomological Museum, Mississippi State University, Starkville, and in the personal collection of T. C. Lockley. An exceptionally thorough manuscript review was provided by D. T. Jennings, with additional reviews by L. Bishop, G. B. Edwards, M. H. Greenstone, N. V. Horner, P. Miller, D. B. Richman, S. B. Roach, and G. Stratton.

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Manuscript received 10 January 1994, revised 12 July 1994.

APPENDIX A—Ground and foliage spiders of an old field habitat, Washington County, Mississippi, March 1985 to May 1986, captured by pitfall traps and sweepnet (entries under monthly headings are mean number per sample, rounded to whole number for species entries and to 0.1 for family entries) (* = <0.5; 1 = 0.5–1.4). (G = ground; F = foliage.) (Ad = adult; Im = immature.)

Taxon	Strata	Life stage	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	Tot. no. indi-vid.	% of strata
Agelenidae	G											3.4	2.0					27	1.5
	F																		
Coras sp.	G	Im											*					1	
C. medicinalis (Hentz)	G	Ad										3	2					26	
Anyphaenidae	G															0.2		1	<1
	F																		
Wulfila sp.	G	Im														*		1	
Araneidae	G			0.1	0.1			0.2				0.2						5	<1
	F		0.5	1.8	3.0		0.8		0.1		1.3	1.5	1.0	0.3	1.0	0.7	0.5	51	4.7
Araneus sp.	G	Im						*										1	
	F	Im					*									*		2	
Cyclosa turbinata (Walck.)	F	Ad		*														1	
Gea heptagon (Hentz)	F	Im										1				*		4	
Leucauge venusta (Walck.)	F	Ad			*													1	
	F	Im		*														1	
Neoscona sp.	G	Im		*	*			*										3	
	F	Im		1	2		1		*									17	
N. arabesca (Walck.)	G	Ad										*						1	
Tetragnatha sp.	F	Im	1	*	*						1	1	1	*	1	*	1	22	
T. laboriosa Hentz	F	Ad		*	*													3	
Clubionidae	G				0.1	0.3		0.1		0.2			0.2	0.2	0.3			9	<1
	F									0.1							0.5	2	<1
Clubiona sp.	G	Im			*										*			2	
	F	Im								*							1	2	
C. obesa Hentz	G	Ad												*				1	
Trachelas sp.	G	Im				*												1	
T. deceptus (Banks)	G	Ad								*			*		*			4	
T. tranquillus (Hentz)	G	Ad						*										1	
Dictynidae	G										0.3	0.2	0.2					4	<1
	F																		

APPENDIX A—Continued.

Taxon	Strata	Life stage	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	Tot. no. individ.	% of strata
Dictyna hentzi Kaston	G	Ad									*	*	*					4	
Gnaphosidae	G			0.2	0.9	0.3	3.2	0.5	0.3	0.4	0.8			0.2		0.2	0.2	55	3.3
	F									0.1	0.8	0.5	1.0				1.0	10	<1
Callilepis imbecilla (Keys.)	G	Ad			*													1	
Drassodes sp.	G	Im			*					*								2	
Gnaphosa sp.	G	Im		*					*	*	*						*	6	
	F	Im								*	1	*					1	7	
G. fontinalis Keys.	G	Ad					1	*			*							10	
Sergiolus sp.	G	Im									*							2	
Zelotes sp.	G	Im						*						*		*		3	
	F	Im										*	1					3	
Z. duplex Chamb.	G	Ad							*									1	
Z. laccus (Barrows)	G	Ad		*	1		*											9	
Undet. genus	G	Im			*	*	2	*		*								21	
Hahniidae	G													0.5	7.3			47	2.8
	F																		
Hahnia sp.	G	Im												1	1			6	
H. cinerea Emerton	G	Ad													7			41	
Linyphiidae	G		3.7	2.0	2.2	2.7	2.2	1.7	1.6	0.6	0.5		0.7	1.8	0.7	0.2	1.0	157	9.3
	F		14.5	5.8	4.0	1.3	0.8			0.1	0.3	0.5	0.5		0.7		0.5	88	8.0
Ceraticelus emertoni (O. P.-Camb.)	F	Ad								*							1	2	
Frontinella pyramitela (Walck.)	F	Ad													1			2	
Undet. genus	G	Ad	4	2	2	3	1	1	1	1	1		1	2	1	*	1	133	
	G	Im		*	*		1	*	*	*				*			*	24	
	F	Ad	4	3	3	1	*				*	*	*					41	
	F	Im	11	3	1	*	*					*						43	
Lycosidae	G		19.7	12.5	4.8	5.7	14.3	15.9	11.3	7.8	3.3	5.3	4.7	5.8	14.5	11.8	14.5	1149	68.0
	F		0.5	1.0	0.2	0.3		0.1		0.1	1.3	2.3	0.5	1.0	1.0	0.9	0.5	38	3.5
Allocosa sp.	G	Im		*			1	1	*	*	1	1	*	1	2	2	1	74	
A. absoluta (Gertsch)	G	Ad	2	1		*	2	3	*	*	*	*			1	*	1	79	
A. funerea (Hentz)	G	Ad		*	*	2									*		1	12	
Arctosa sp.	G	Im										*					*	2	
Lycosa sp.	G	Im		1	*		9	1	5	*	*	*	*	1	*	2	5	194	

APPENDIX A—Continued.

Taxon	Strata	Life stage	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	Tot. no. individ.	% of strata
	F	Im														*		1	
L. acompa Chamb.	G	Ad		1	1		*	*	*	*	*				*	1	1	35	
L. annexa Chamb. and Ivie	G	Ad								*	*					*	*	4	
L. aspersa Hentz	G	Ad						*	*									5	
L. helluo Walck.	G	Ad			*			*		1	*				*	1	2	31	
L. lenta (Hentz)	G	Ad		*	1			*		*						4	1	42	
L. rabida Walck.	G	Ad				*	*											2	
	F	Im												*		*		2	
Pardosa sp.	G	Im		1	*			*	*		*	2	2	2	1			54	
	F	Im	1	*	*	*		*			1	1	1	1		*	1	17	
P. milvina (Hentz)	G	Ad	17	8	1	*	*		*		1	*	*	3	7	2	1	237	
	F	Ad									*				*			2	
P. saxatilis (Hentz)	G	Ad		*				*				*			*			10	
Pirata sp.	G	Im								*								1	
	F	Im		1						*		1		*	1			9	
P. insularis Emerton	G	Ad					*								*	*		3	
P. minutus Emerton	F	Ad									*							1	
Schizocosa sp.	G	Im	*	*	*			6	*	4	1	1	1		1	1		160	
	F	Im		*							*	1						4	
S. avida (Walck.)	G	Ad			*			*	*	*								18	
Schizocosa sp. (*ocreata* sp. group)	G	Ad		*	1	*	1	*	*	*	*	1	1			1	1	48	
	F	Ad														*		2	
Trabeops sp.	G	Im										*			*			3	
T. aurantiaca (Emerton)	G	Ad	*									*			*			3	
Trochosa sp.	G	Im															1	3	
T. avara Keys.	G	Ad			*			*	*			*						9	
Undet. genus	G	Im		*	1	4		3	3	1	*			*	*	*		120	
Oxyopidae	G			0.1			0.2				0.2			0.2			0.3	6	<1
	F			1.5	0.8	8.7	2.0	0.9		2.9	11.5	7.0	10.0	4.8	7.3	6.7	0.5	258	23.5
Oxyopes salticus Hentz	G	Ad		*							*						*	4	
	G	Im					*							*				2	
	F	Ad		*				*								7	1	52	
	F	Im		1	1	9	2	*		3	12	7	10	5	7			206	

APPENDIX A—Continued.

Taxon	Strata	Life stage	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	Tot. no. indivd.	% of strata
Pisauridae	G								0.1	0.1								2	<1
	F									0.1	1.8	0.8				0.7		16	1.5
Pisaurina sp.	G	Im							*	*								2	
	F	Im								*		*				*		5	
P. mixa (Hentz)	F	Im									2	1				*		11	
Salticidae	G			0.1	0.6	1.3	0.7	1.1	0.6	0.2						0.3	0.7	44	2.6
	F		1.0	1.5	3.6	13.3	17.4	2.9	2.6	6.4	9.3	0.8	2.0	0.5	0.7	8.9	1.5	358	32.7
Agassa cyanea (Hentz)	F	Ad									1							2	
	F	Im										1						2	
Corythalia latipes C.L. Koch	G	Ad														*		1	
Eris sp.	F	Im														1		7	
Habrocestrum pulex (Hentz)	G	Ad			*			*	*									4	
Habronattus sp.	G	Im			*	*	1	*	*	*							*	10	
	F	Im					*	*		*	1			1	*			15	
H. agilis (Banks)	G	Ad								*								1	
H. coecatus (Hentz)	G	Ad		*		*	*	1	*								*	12	
	F	Ad					*	*			*							4	
Marpissa bina (Hentz)	G	Ad														*		1	
M. lineata (C.L. Koch)	G	Ad															*	1	
Metaphidippus sp.	F	Im			*	4	*			2						1		38	
M. galathea (Walck.)	G	Ad			*													1	
	F	Ad			*	*	*	*	*	1	*					*		16	
Phidippus sp.	F	Im	1	2	2	1	10	1	2	2			1					109	
P. audax (Hentz)	G	Ad															*	1	
	G	Im				*			*									3	
	F	Ad							*	*								5	
P. clarus Keys.	G	Ad						*										1	
	F	Ad															*	1	
Sassacus papenhoei Peckhams	F	Im								*								1	
Tutelina elegans (Hentz)	F	Ad							*									1	
Zygoballus sp.	F	Im																34	
Z. rufipes Peckhams	F	Ad													*	5	1	11	
Z. sexpunctatus (Hentz)	F	Ad														2		1	
Undet. genus	F	Im			1	8	6	1		1	7	*	1			*		112	
	G	Im			*	*		*	*								1	8	

APPENDIX A—Continued.

Taxon	Strata	Life stage	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	Tot. no. individ.	% of strata
Theridiidae	G			0.2														2	<1
	F									0.1								1	<1
Theridion sp.	F	Im								*								1	
T. frondeum Hentz	G	Ad		*														2	
Theridiosomatidae	G																		
	F						0.2											1	<1
Theridiosoma gemmosum (L. Koch)	G	Im					*											1	
Thomisidae	G		1.0	3.2	3.5	4.0	5.8		0.8	0.4	0.5		0.2			2.0	2.8	177	10.5
	F		1.0	5.0	5.4	10.3	10.4	2.4	1.5	13.4	0.8	0.5		0.3				274	25.0
Coriarachne sp.	G	Im					*											2	
	F	Im	*															1	
Misumena vatia (Clerck)	F	Im		*						*	*							3	
Misumenoides formosipes (Walck.)	F	Im						*	*	13								110	
Misumenops sp.	F	Im		4	5	10	10	2	1	*	*							149	
M. asperatus (Hentz)	F	Ad		*														1	
M. oblongus (Keys.)	F	Ad	1	1	*													5	
Oxyptila sp.	G	Im					1											7	
O. monroensis Keys.	G	Ad															*	1	
	F	Im									*			*				2	
Xysticus sp.	G	Im	1	2	1	3	3		1	*	1		*					75	
	F	Im										1						2	
X. ferox (Hentz)	G	Ad		2	3	1	1									2	2	84	
	F	Ad		*														1	
X. fraternus Banks	G	Ad		*	*												1	8	
Uloboridae	G						0.3									0.2		3	<1
	F															0.1		1	<1
Uloborus sp.	G	Im					*									*		3	
	F	Im														*		1	
Total no. individuals	G		73	220	146	43	161	233	174	116	33	49	47	52	136	89	116	1689	
	F		34	662	857	10	15	446	348	18	10	55	30	276	32	12	10	1096	
Mean no. per sample	G		23	18	12	15	27	19	15	10	6	8	8	9	23	15	19	15	
	F		17	17	17	34	31	6	4	23	27	14	15	7	11	18	5	16	
No. trap samples	G		3	12	12	3	6	12	12	12	6	6	6	6	6	6	6	114	
No. sweep samples	F		2	4	5	3	5	7	8	8	4	4	2	4	3	7	2	68	